Interference Lithography of graphene oxide with a table-top X-ray laser source

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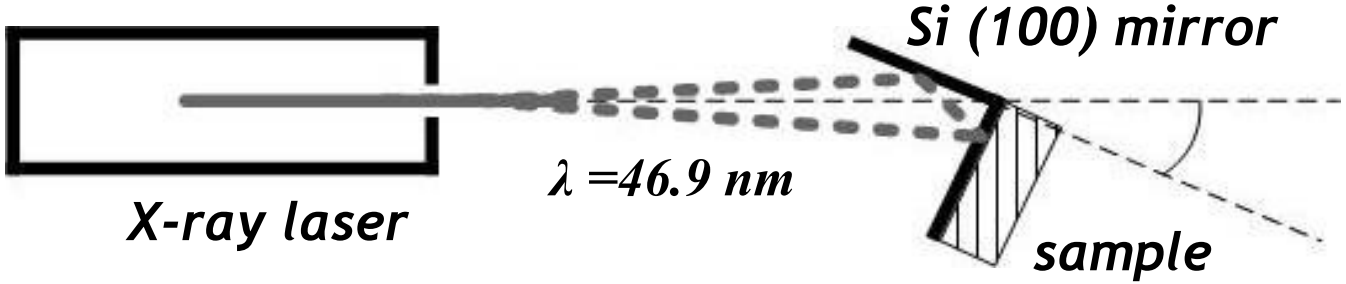
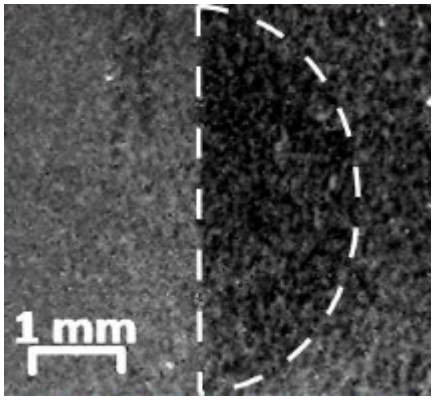
2010 International Workshop on Extreme Ultraviolet Sources
University College Dublin
November 13 - 15, 2010

The XIL setup
(Lloyd's configuration)

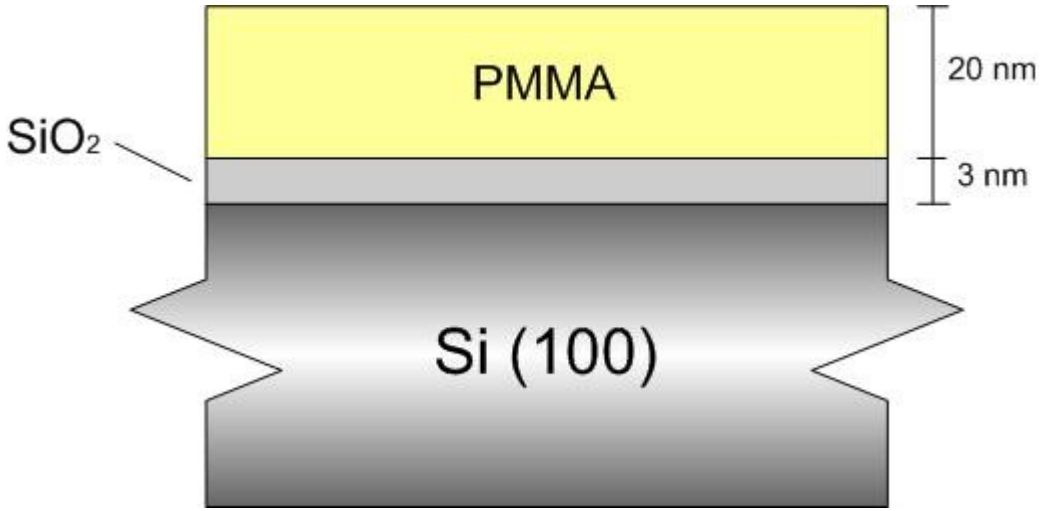




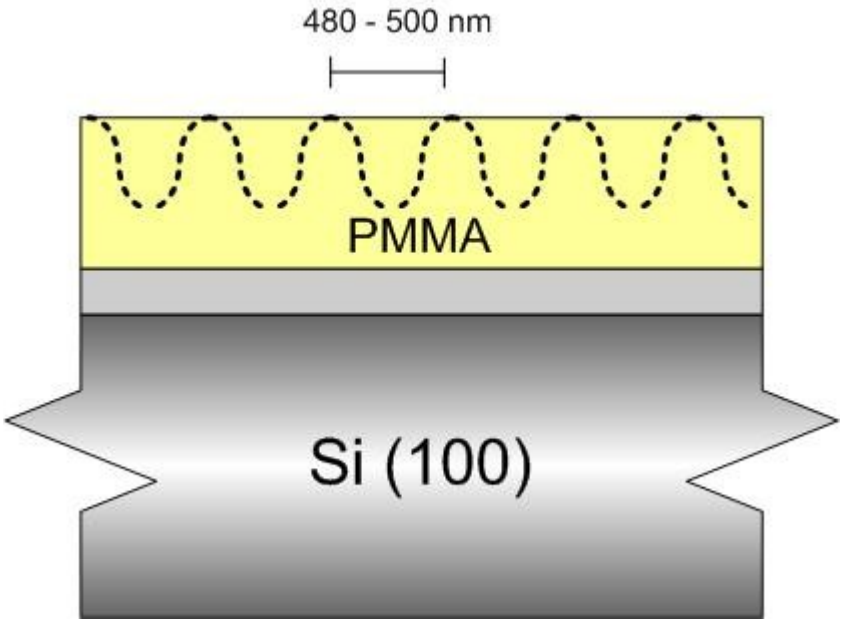
Beam Divergence : ≤ 5 mrad
Pulse Duration : 1.7 ns
Energy delivered per pulse: 150 μJ
Pulse rate: 0.1 Hz

$$\Delta x = \frac{\lambda}{(2\sin\theta)}$$

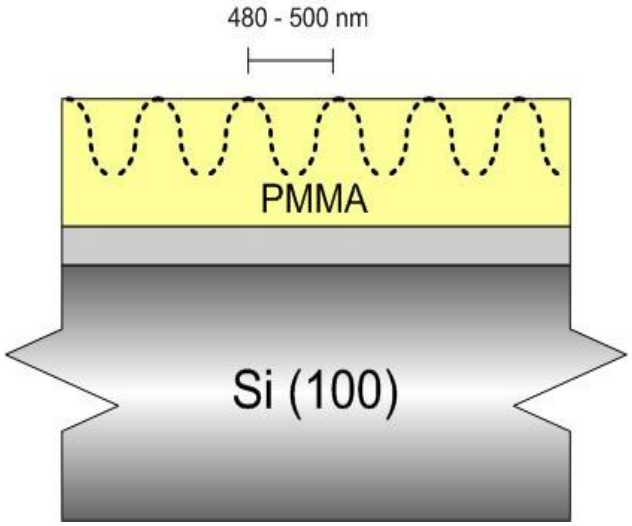
Fabrication of the samples
By XIL : the "old" story

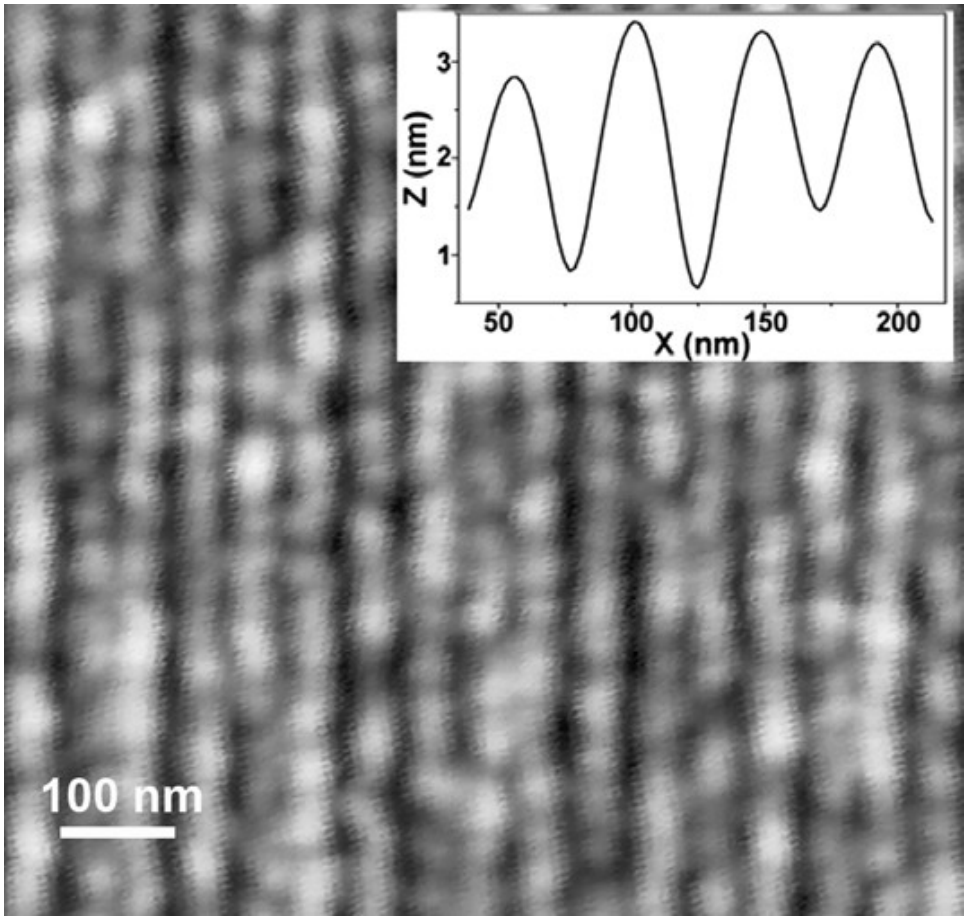


Fabrication of the samples
(XIL exposure): the "old" story



Technique: X-ray Interference Lithography

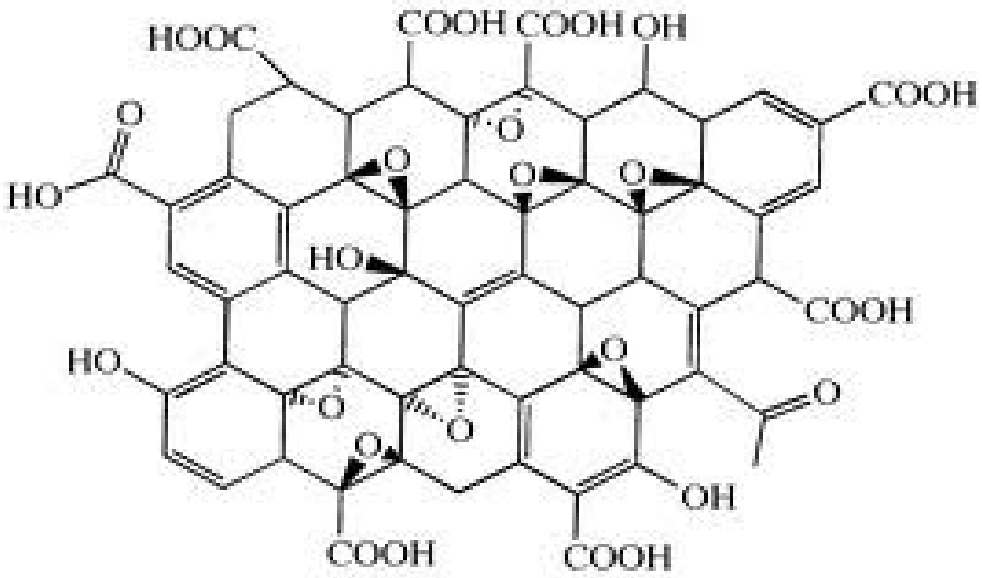




P. Zuppella, L. Ottaviano et al., Nanotechnology ***20****, 115303 (2009)*

The “new” story.

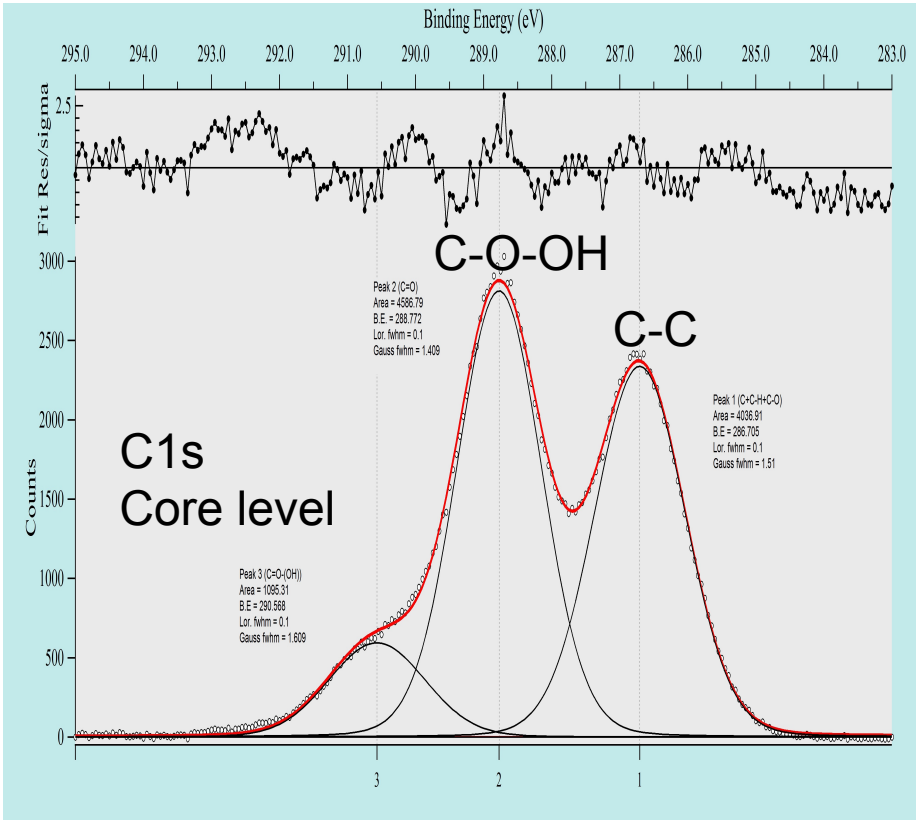
Idea: lithography on Graphene Oxide



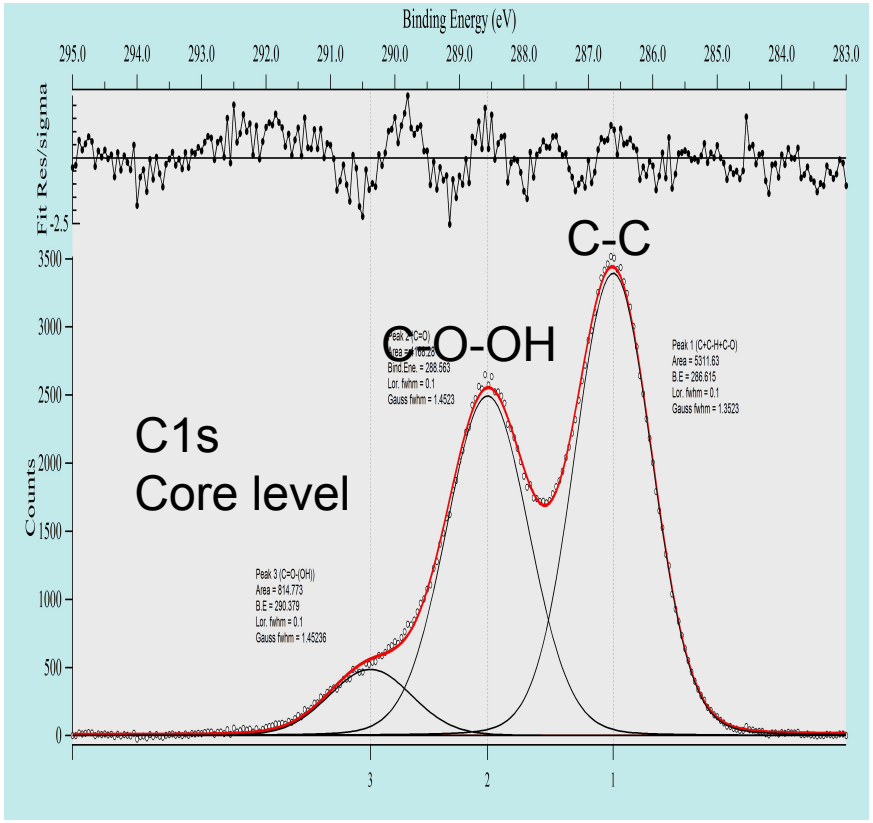
The “new” story.
Idea: lithography on Graphene Oxide

XPS Analysis $GO/SiO_2/Si(100)$

Before exposure to the X-ray Beam

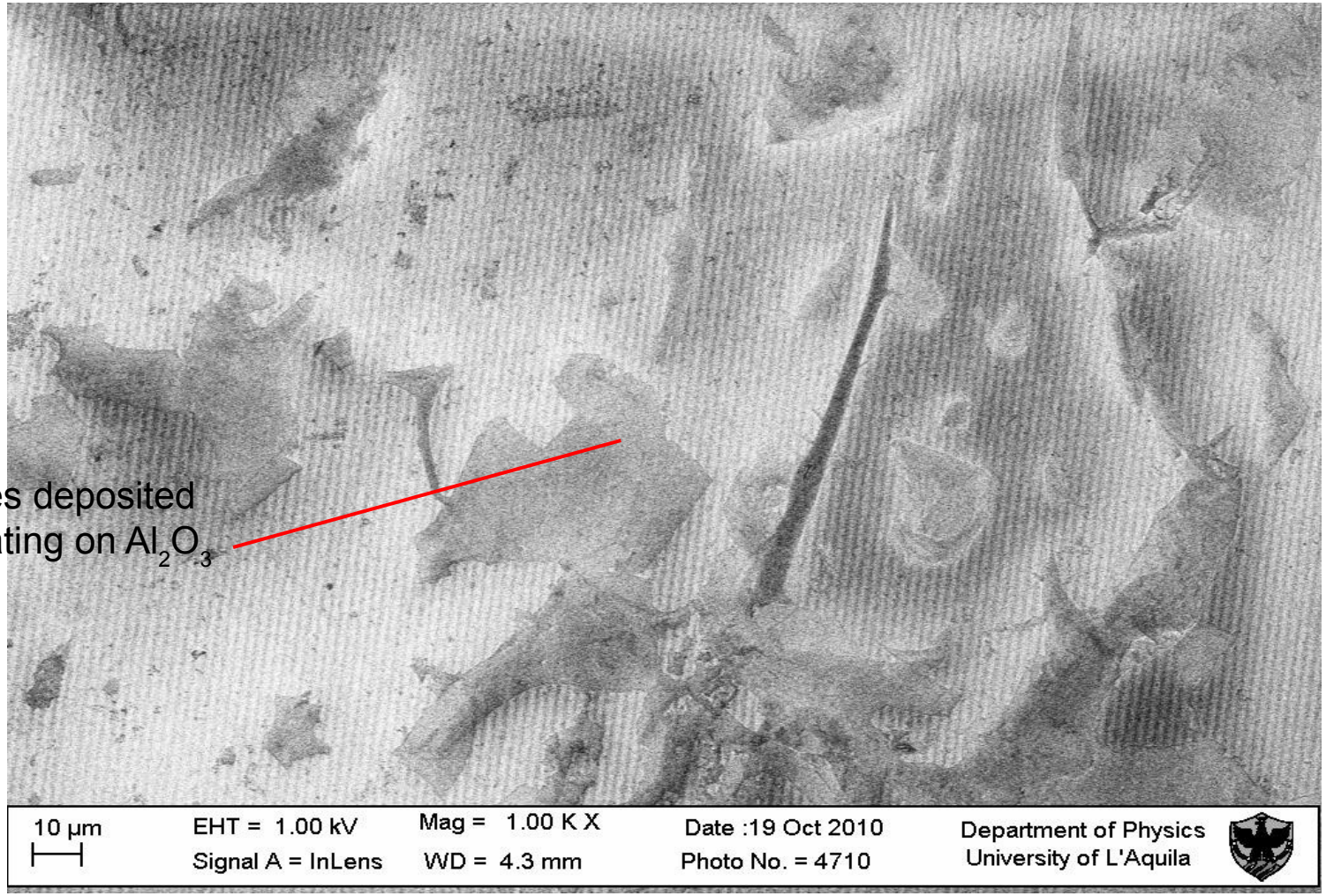


After exposure to the X-ray Beam (200 shots)

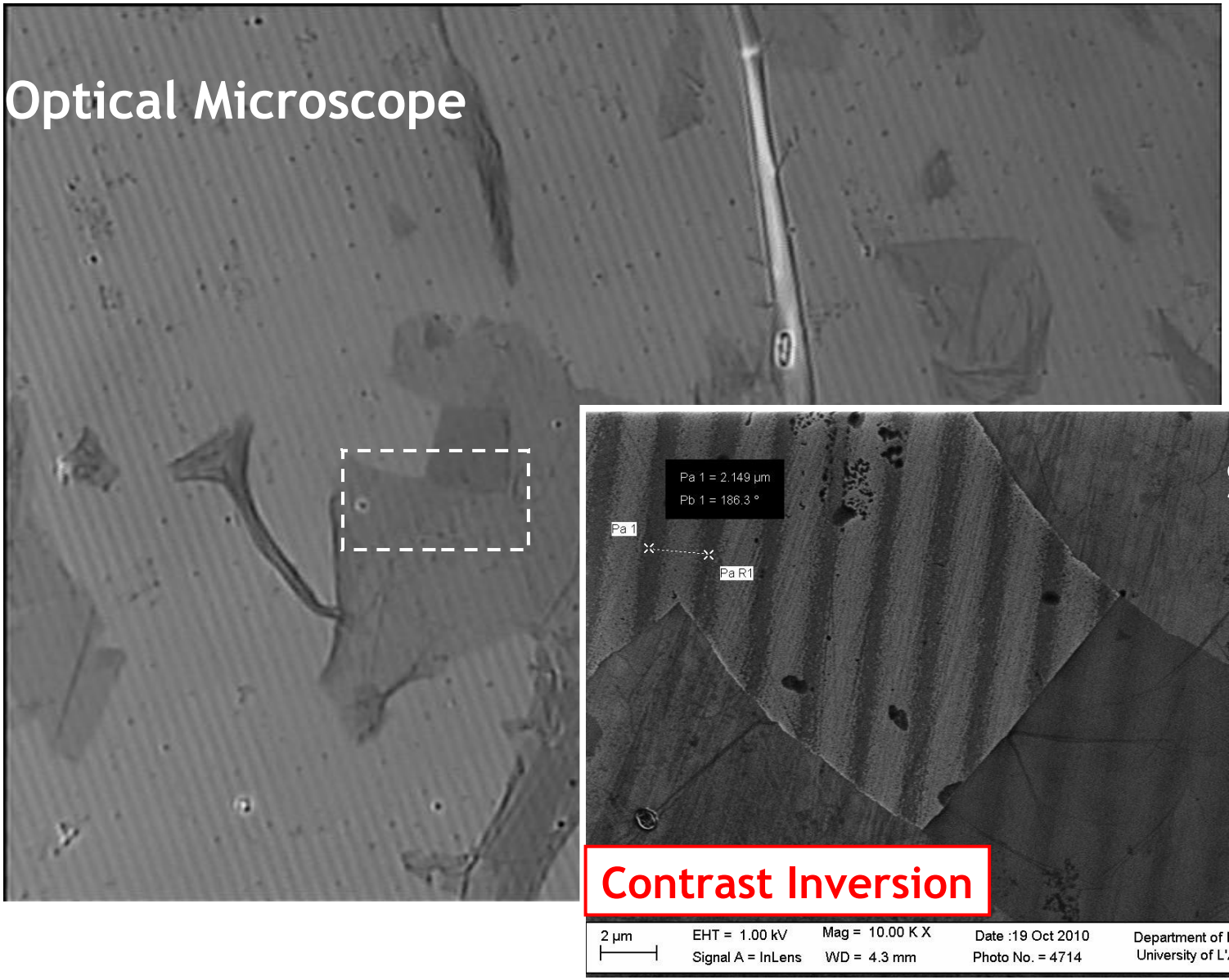


The “new” story: lithography on Graphene Oxide (GO)

GO Flakes deposited by dip coating on Al_2O_3

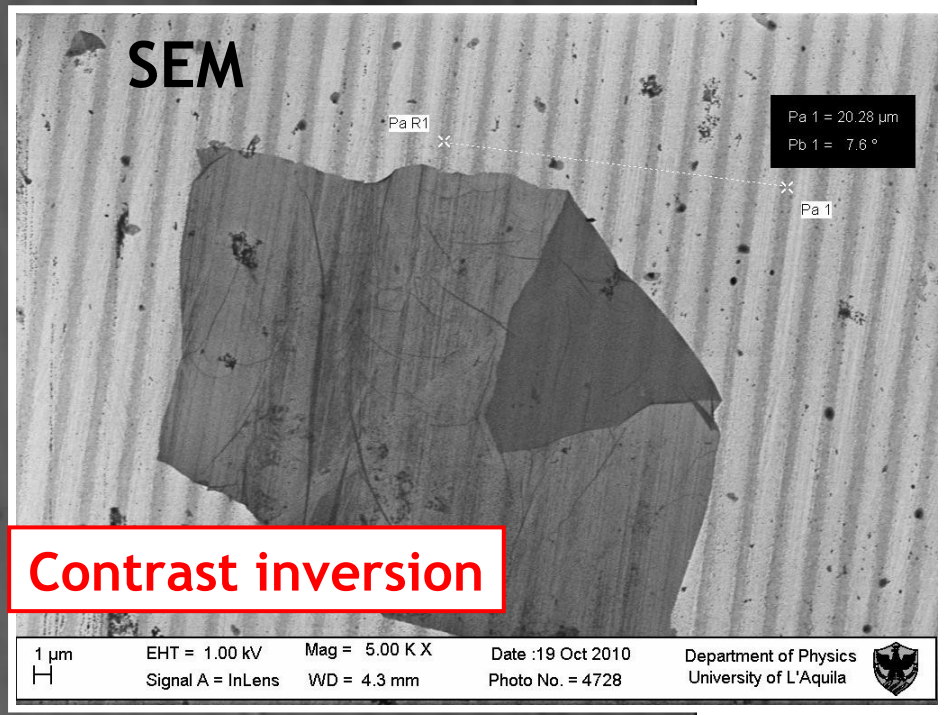


XIL lithography on GO/Al_2O_3 (72 nm)/Si(100)

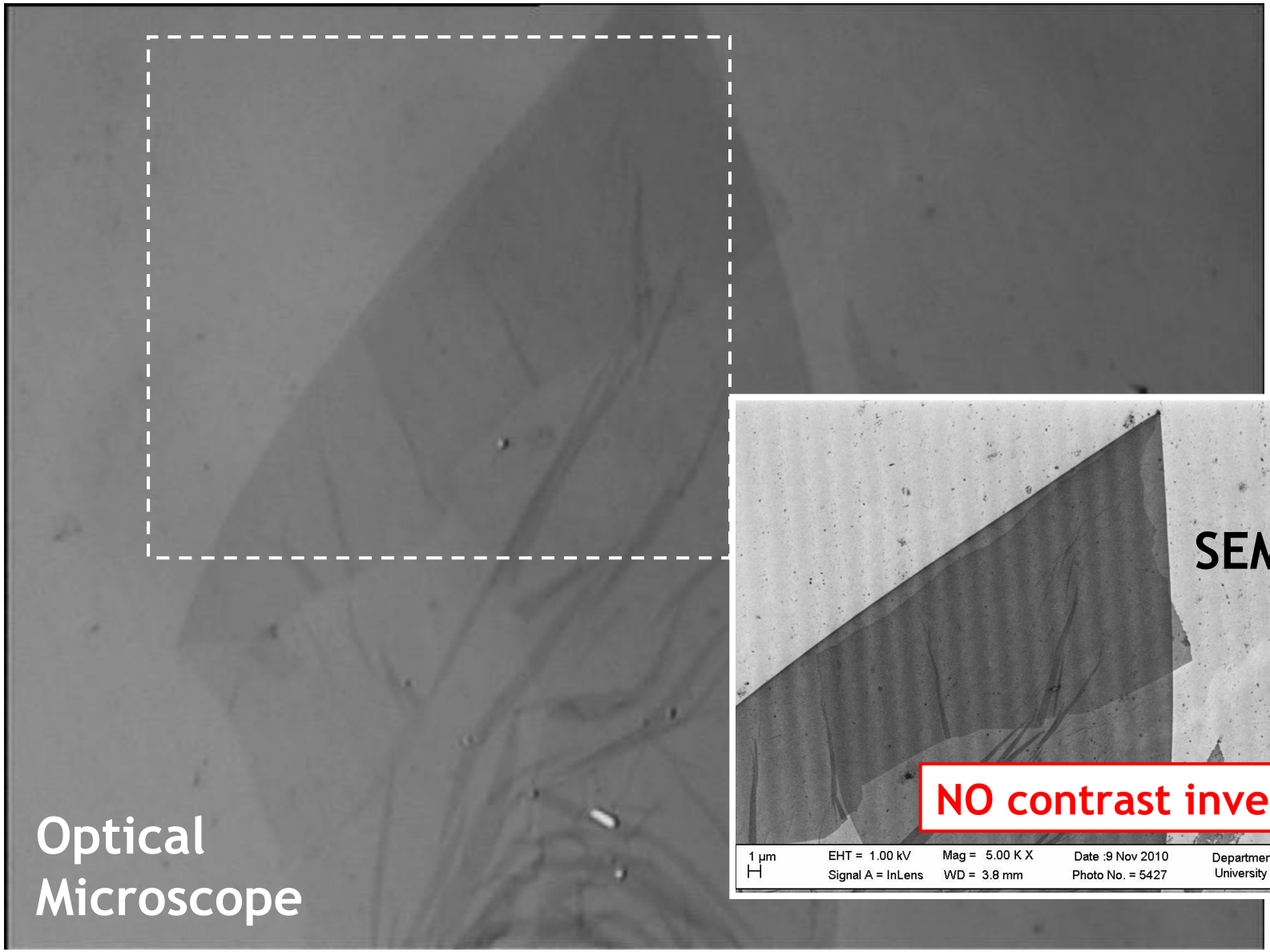


XIL lithography on GO/Al_2O_3 (72 nm)/Si(100)

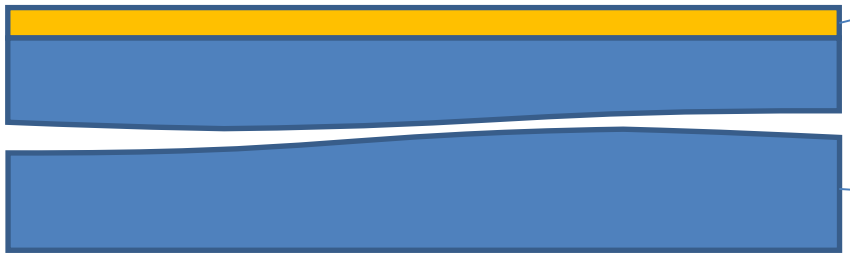
Optical Microscope



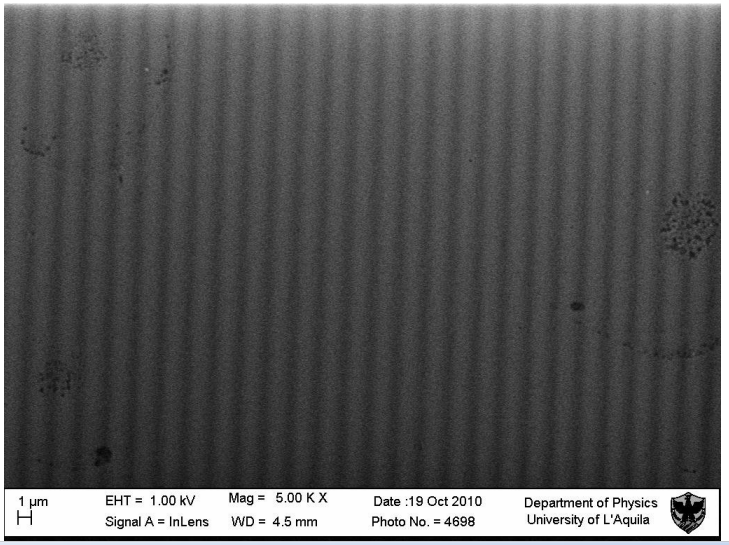
XIL lithography on Al_2O_3 (72 nm)/Si(100) and subsequent deposition of GO



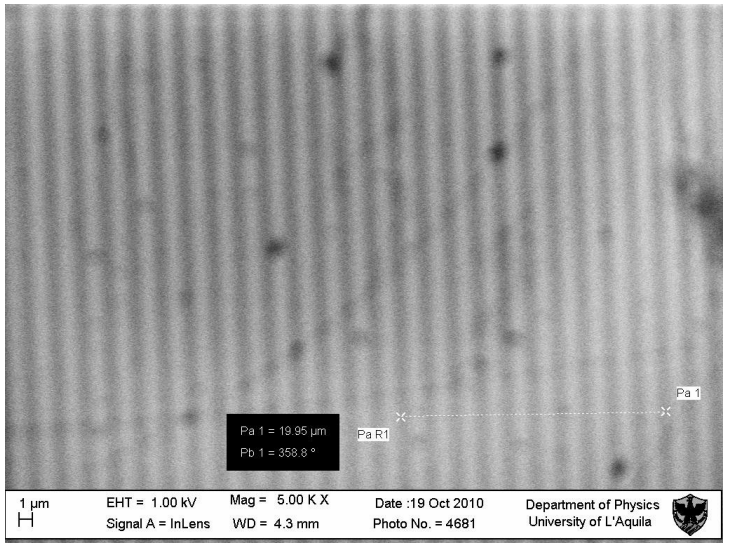
The Samples



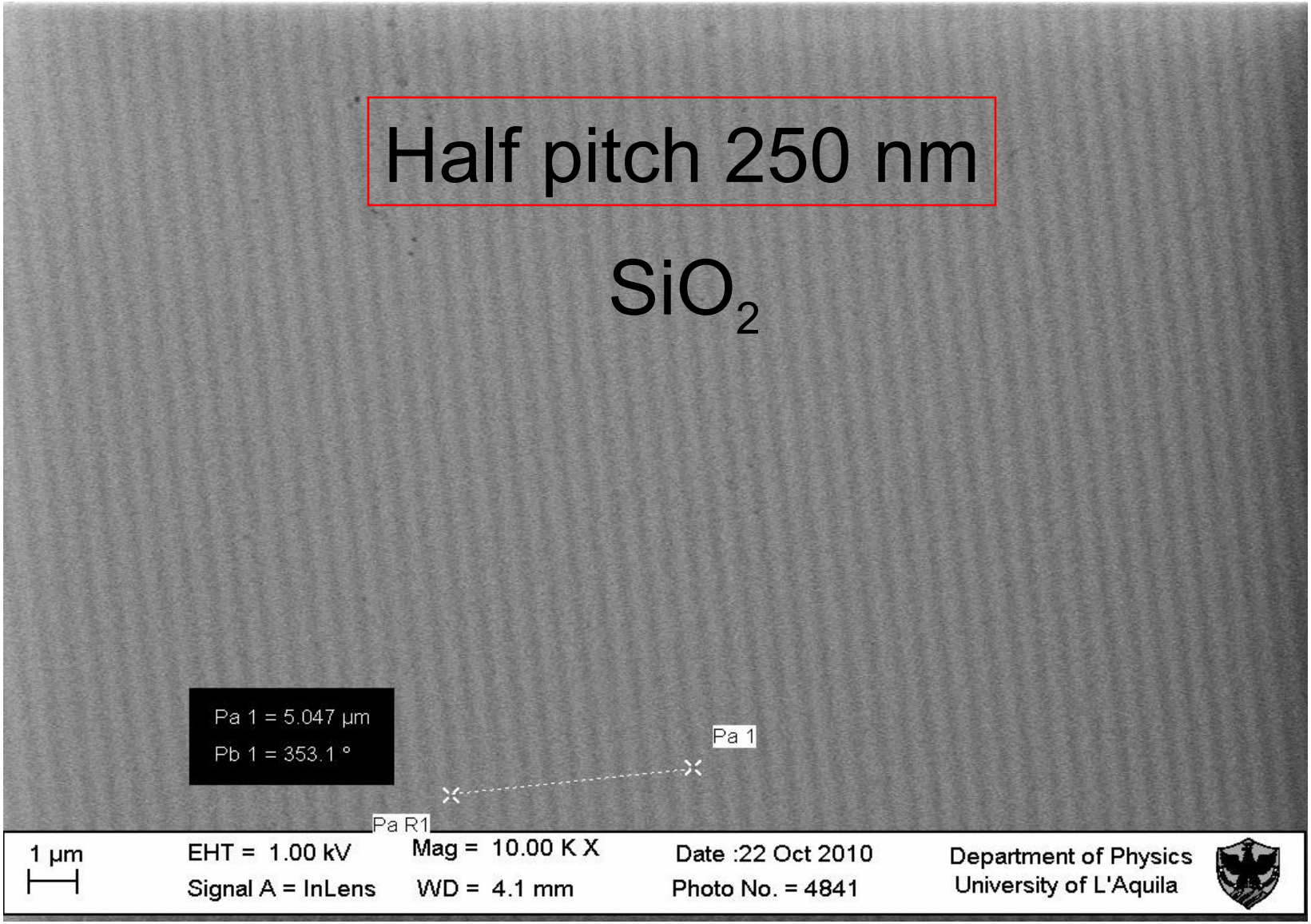
SiO_2



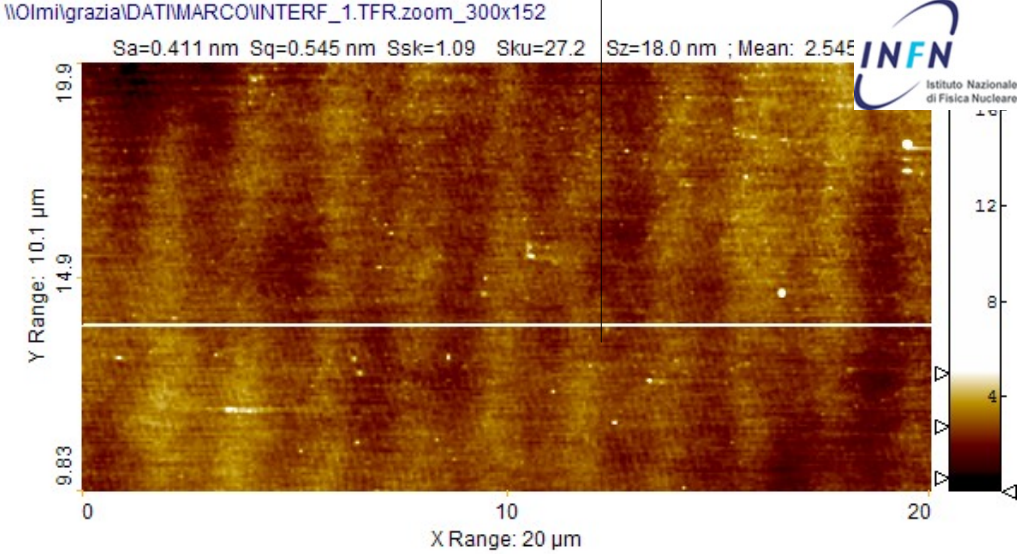
Al_2O_3

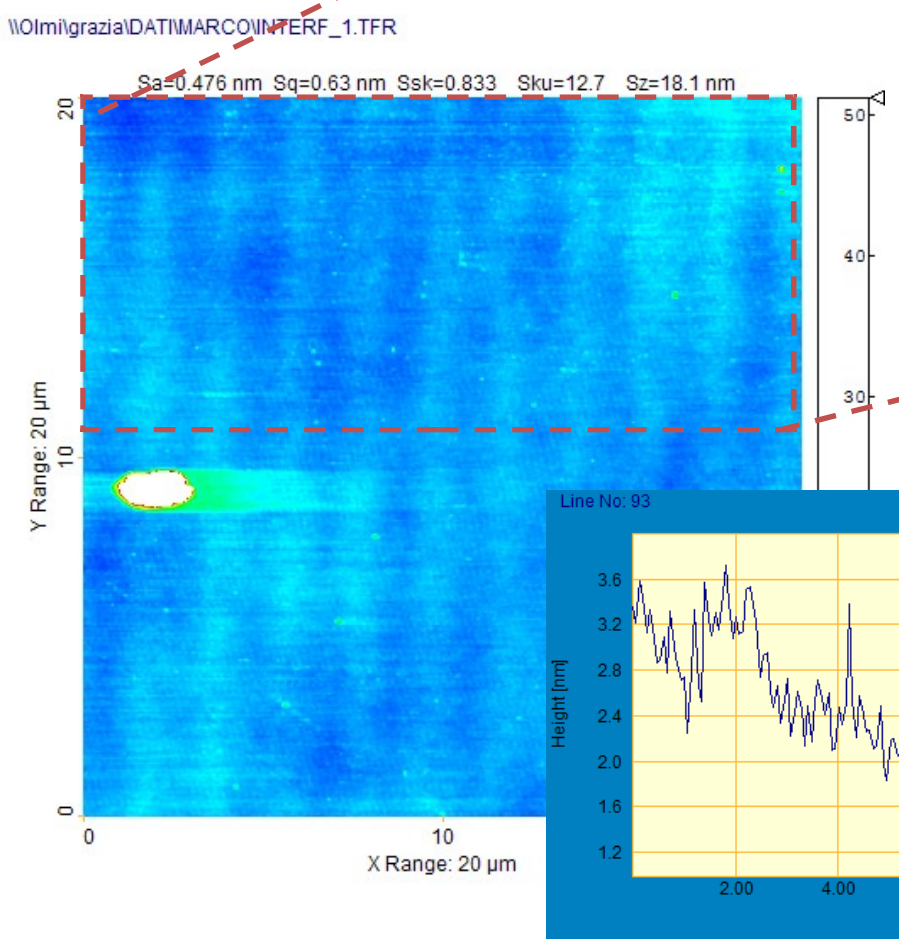


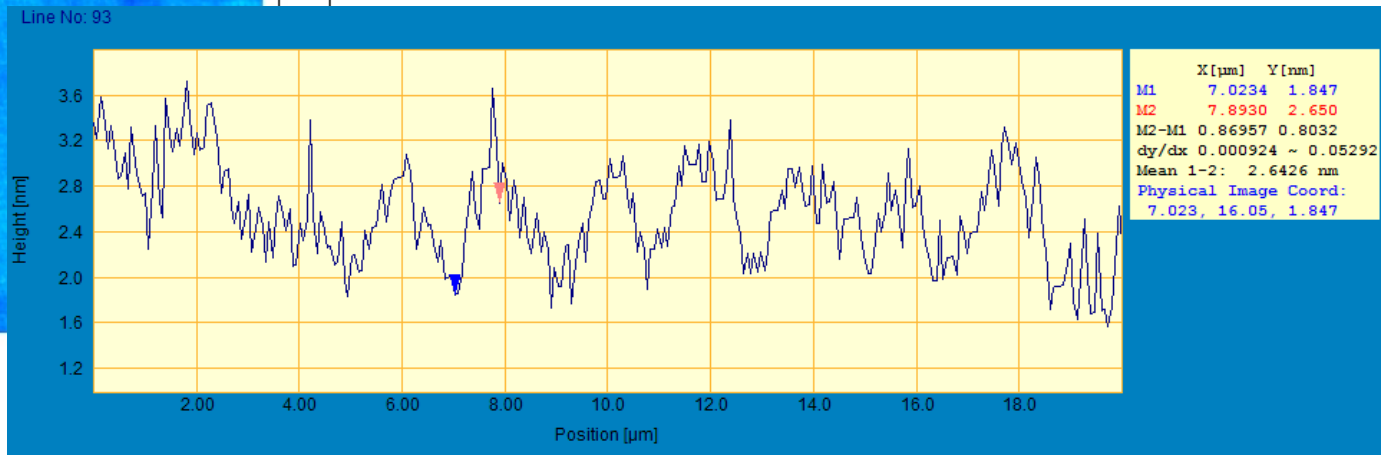
Resistless XIL on SiO_2



AFM on SiO_2


\\Olmi\grazia\DATI\MARCO\INTERF_1.TFR.zoom_300x152
Sa=0.411 nm Sq=0.545 nm Ssk=1.09 Sku=27.2 Sz=18.0 nm ; Mean: 2.545
Y Range: 10.1 µm
19.9
14.9
9.83
0
10
20
X Range: 20 µm
12
8
4


\\Olmi\grazia\DATI\MARCO\INTERF_1.TFR
Sa=0.476 nm Sq=0.63 nm Ssk=0.833 Sku=12.7 Sz=18.1 nm
Y Range: 20 µm
20
10
0
0
10
X Range: 20 µm
50
40
30


Line No: 93
Height [nm]
3.6
3.2
2.8
2.4
2.0
1.6
1.2
2.00
4.00
6.00
8.00
10.0
12.0
14.0
16.0
18.0
Position [µm]
X[µm] Y[nm]
M1 7.0234 1.847
M2 7.8930 2.650
M2-M1 0.86957 0.8032
dy/dx 0.000924 ~ 0.05292
Mean 1-2: 2.6426 nm
Physical Image Coord:
7.023, 16.05, 1.847

Conclusions

- Efficient Classical lithography by XIL
- Lithography on GO
- Resistless lithography on Silicon Oxide and Alumina (250 nm half pitch)

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INVITATION TO

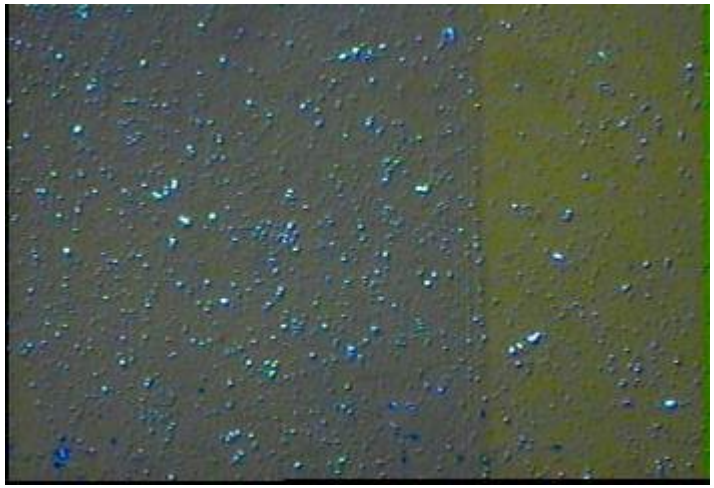
http://graphita.bo.imm.cnr.it

A European Workshop on Graphene
L'Aquila May 15-18 2011

Resistless XIL on Al_2O_3

10 s etching: 20% HCl, 80% H_2O

Optical microscope 20 X



Optical microscope 100 X